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Arai et al.

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[45] **Date of Patent: Mar. 29, 1988**

[54] **REVERSING SPEED CONTROL SWITCH**

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[73] Assignee: **Fujisoku Electric Co., Ltd.,** Kawasaki, Japan

[21] Appl. No.: **7,340**

[22] Filed: **Jan. 27, 1987**

[30] **Foreign Application Priority Data**

Aug. 5, 1985 [JP] Japan 60-119313

[51] **Int. Cl.**[4] **H01H 9/00;** H01H 21/00

[52] **U.S. Cl.** ..... **200/1 V;** 200/11 K; 200/157

[58] **Field of Search** ..... 200/1 V, 5 R, 11 R, 200/11 G, 11 J, 11 K, 14, 157, 291; 310/47, 50, 68 A; 318/345 R

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Primary Examiner—J. R. Scott

Attorney, Agent, or Firm—Ladas & Parry

[57] **ABSTRACT**

Disclosed is a reversing speed control switch. This control switch has a trigger arranged on a casing, a movable element which is moved upon operation of the trigger, a power switch for switching, on and off, a power source to be interlocked with the operation of the movable element, a reversing switch, connected to the switch, for switching the polarity of the power source, a reversing actuator whose shaft portion coupled to the reversing switch is located in the central portion the casing, and whose actuation portion is located outside the casing, and a speed control circuit for performing speed control, upon operation of the trigger. The movable element, the switch, and the speed control circuit are arranged around the shaft portion.

5 Claims, 14 Drawing Figures

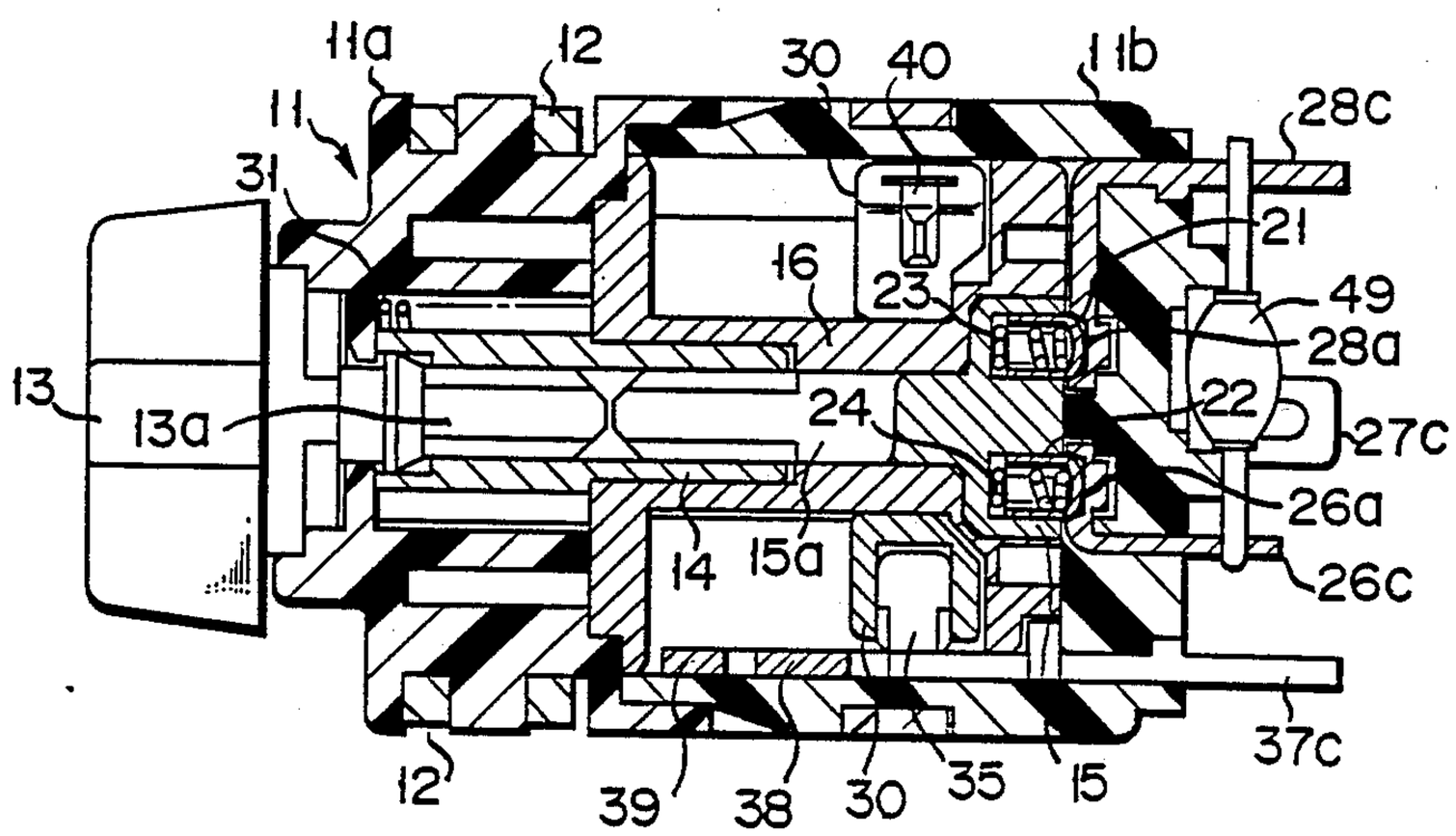


FIG. 1

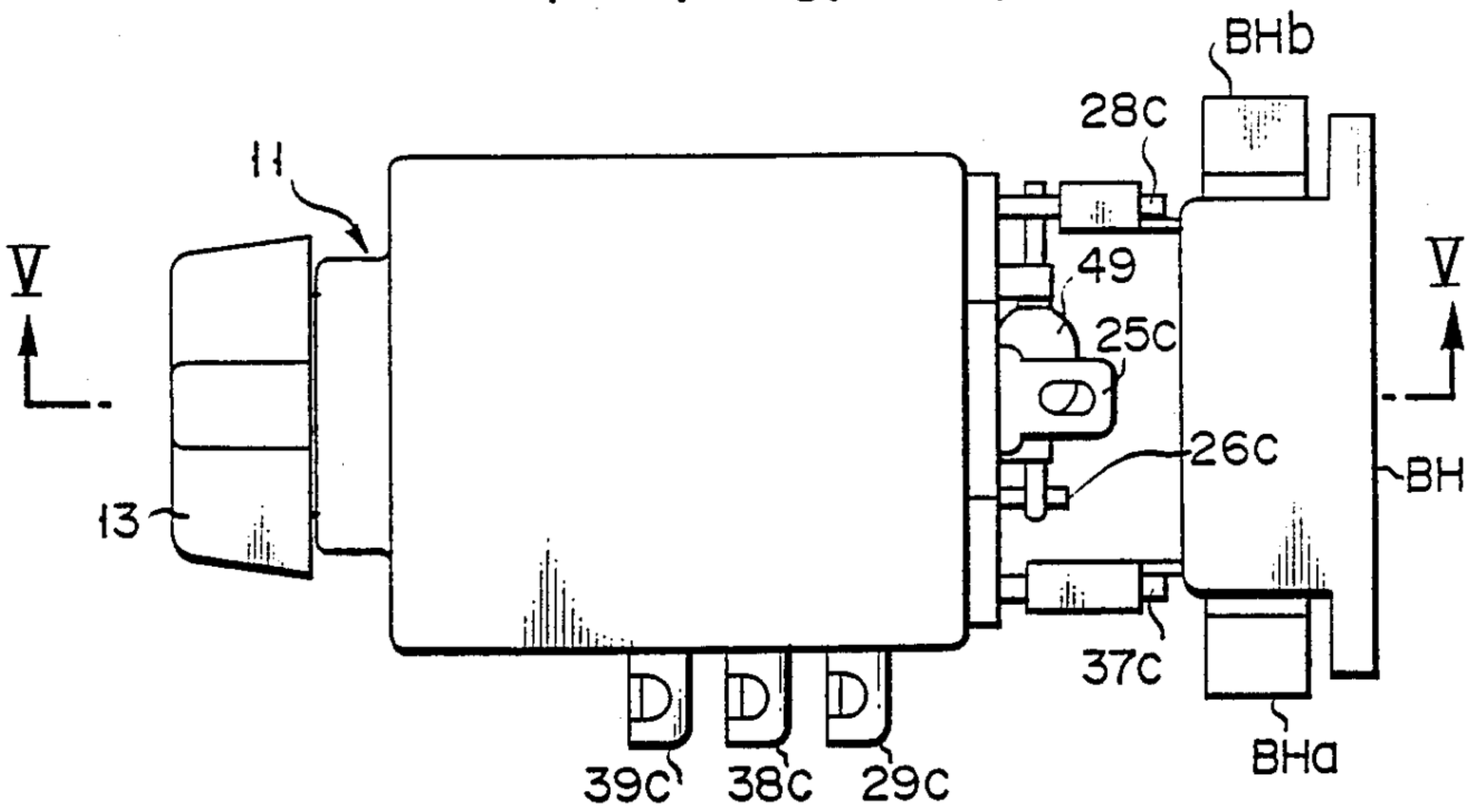

BHb
28c
11
V
V
49
25c
26c
BH
13
37c
39c
38c
29c
BHa

FIG. 2

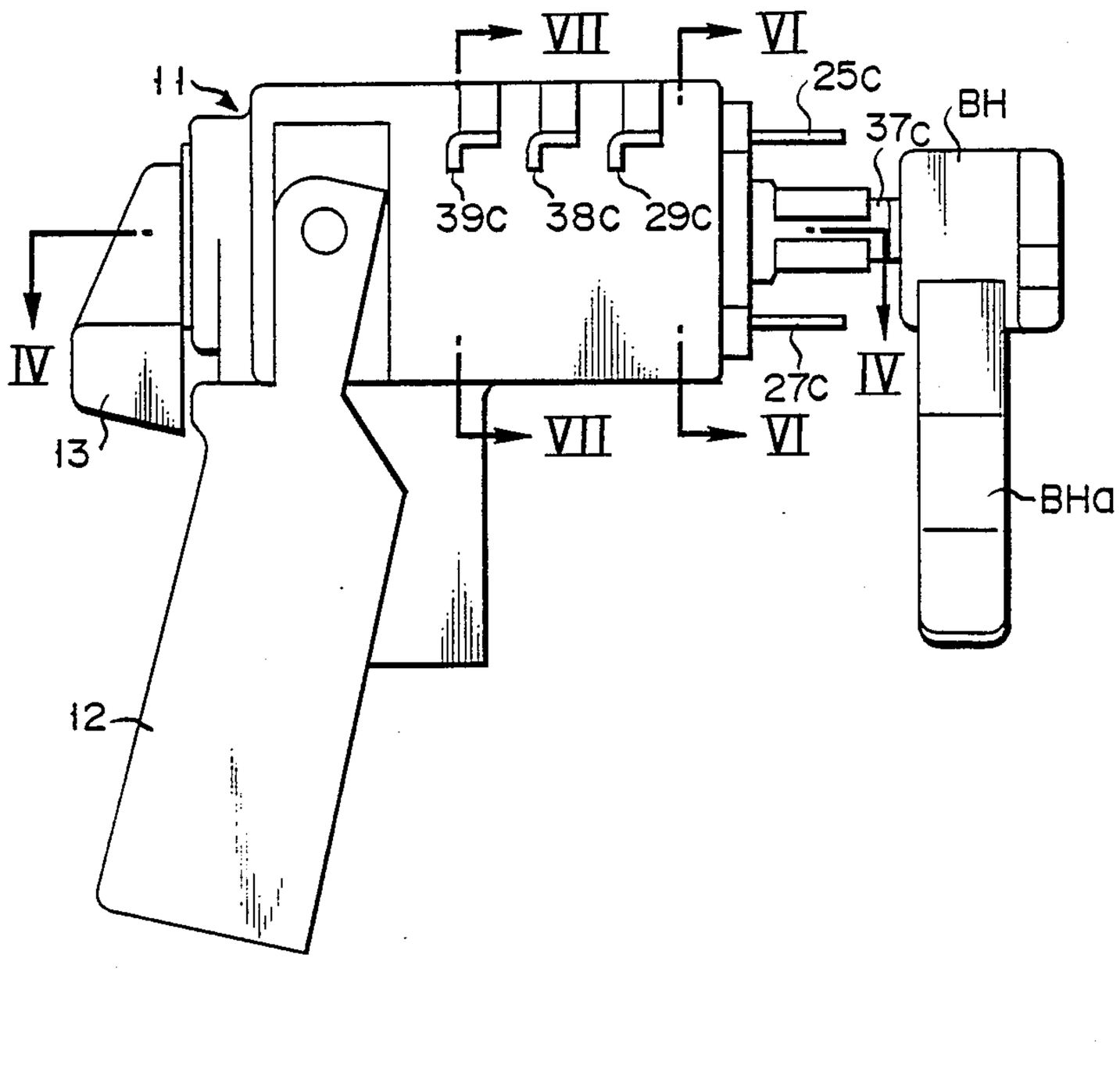

VII
VI
11
25c
37c
BH
39c
38c
29c
IV
IV
27c
VII
VI
13
BHa
12

FIG. 3

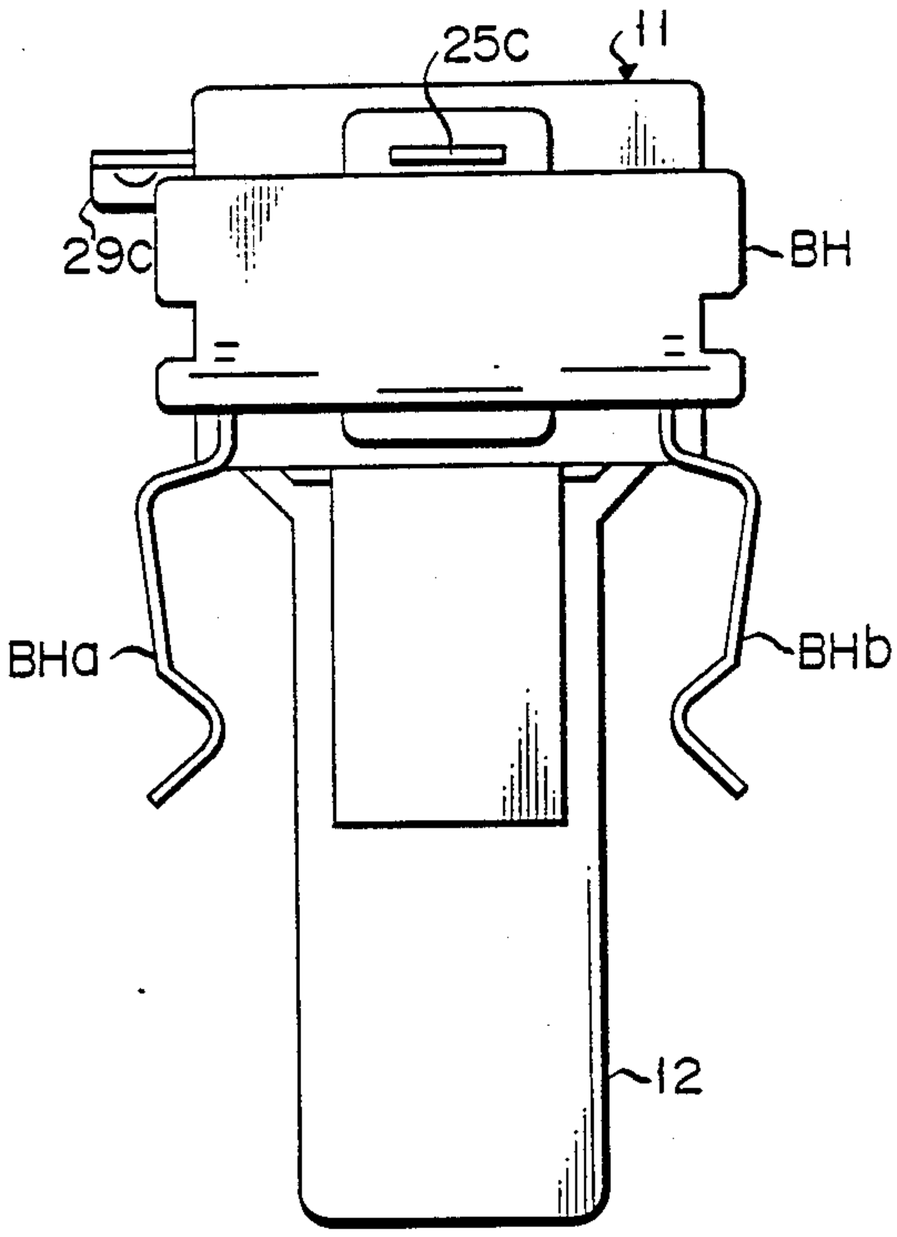

25c
11
29c
BH
BHa
BHb
12

FIG. 4

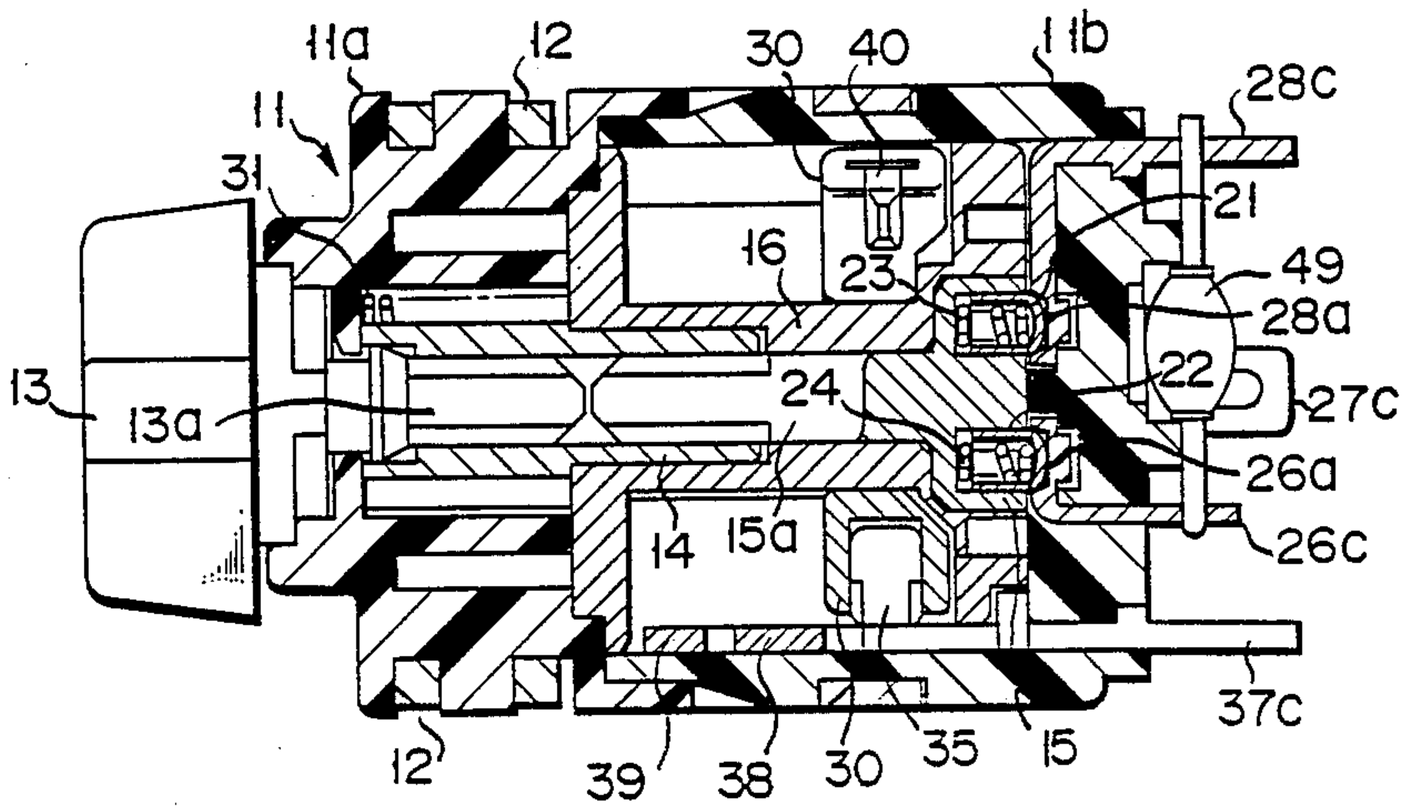

11a
12
30
40
11b
28c
11
31
21
16
23
49
28a
22
27c
13
13a
24
26a
14
15a
26c
37c
12
39
38
30
35
15

FIG. 5

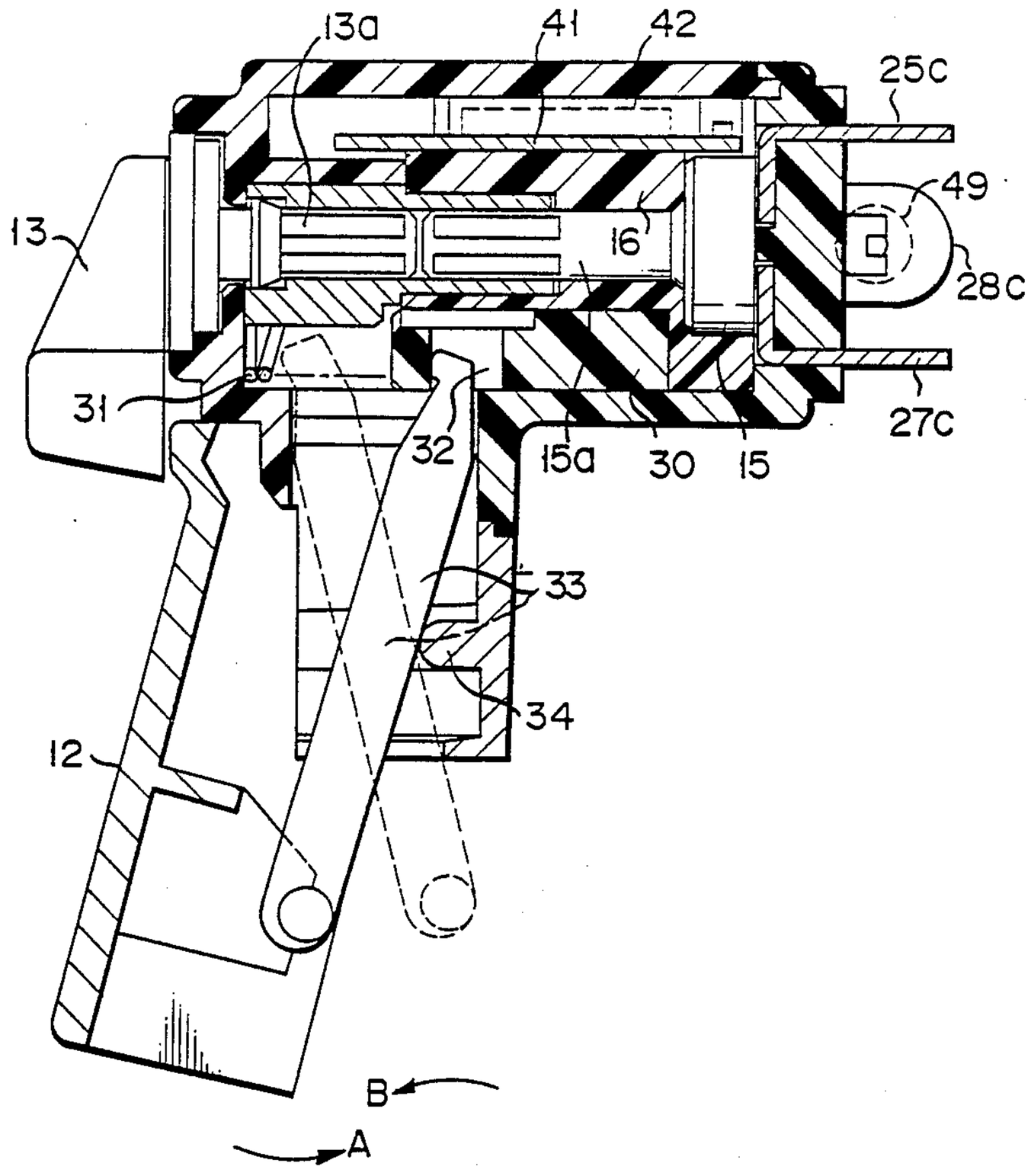


FIG. 6

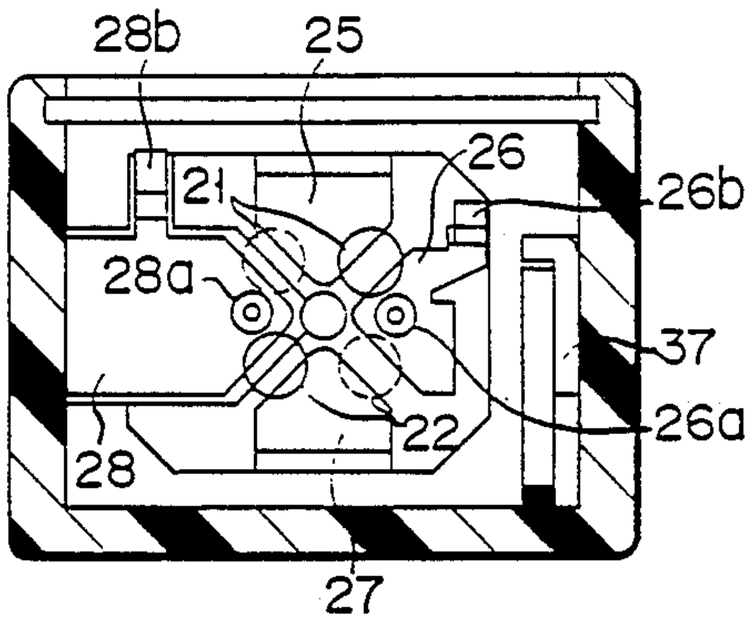


FIG. 7

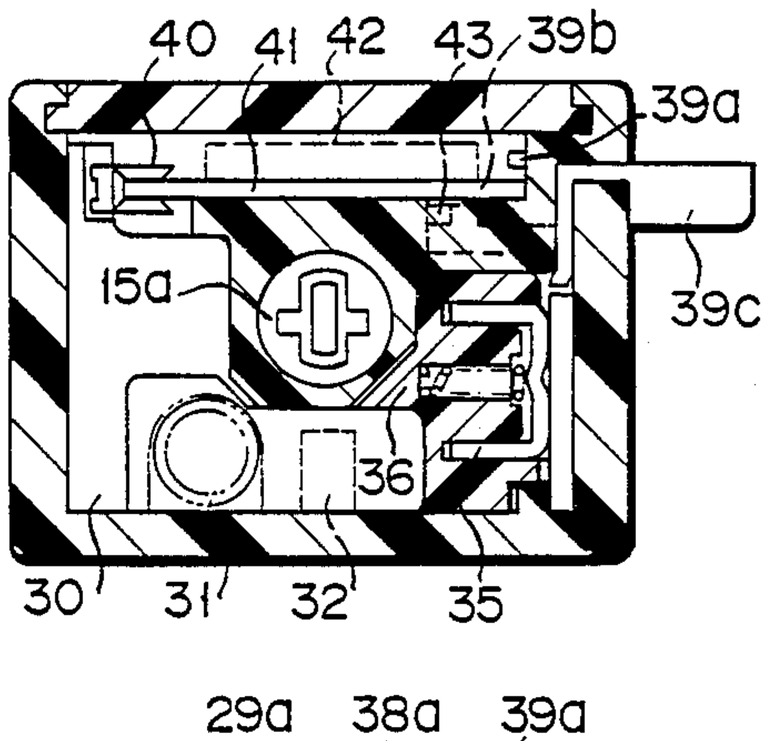


FIG. 8

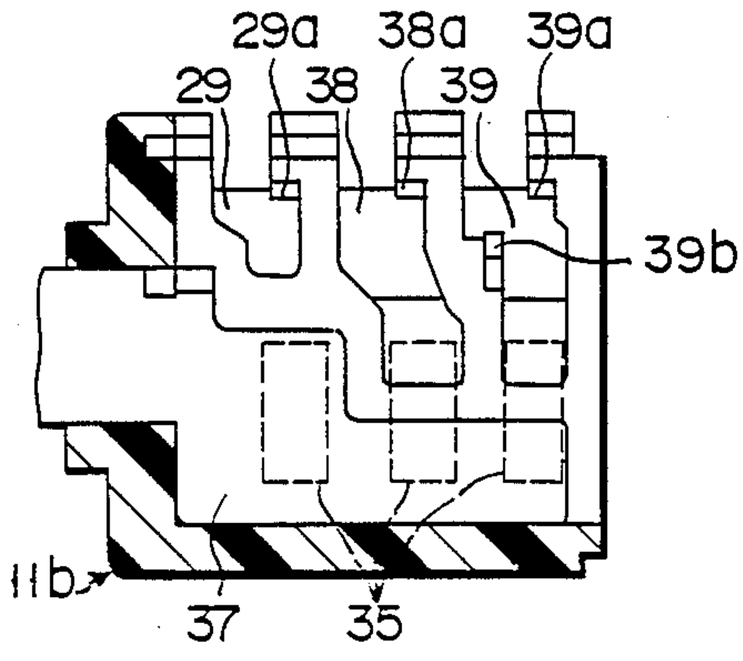


FIG. 9

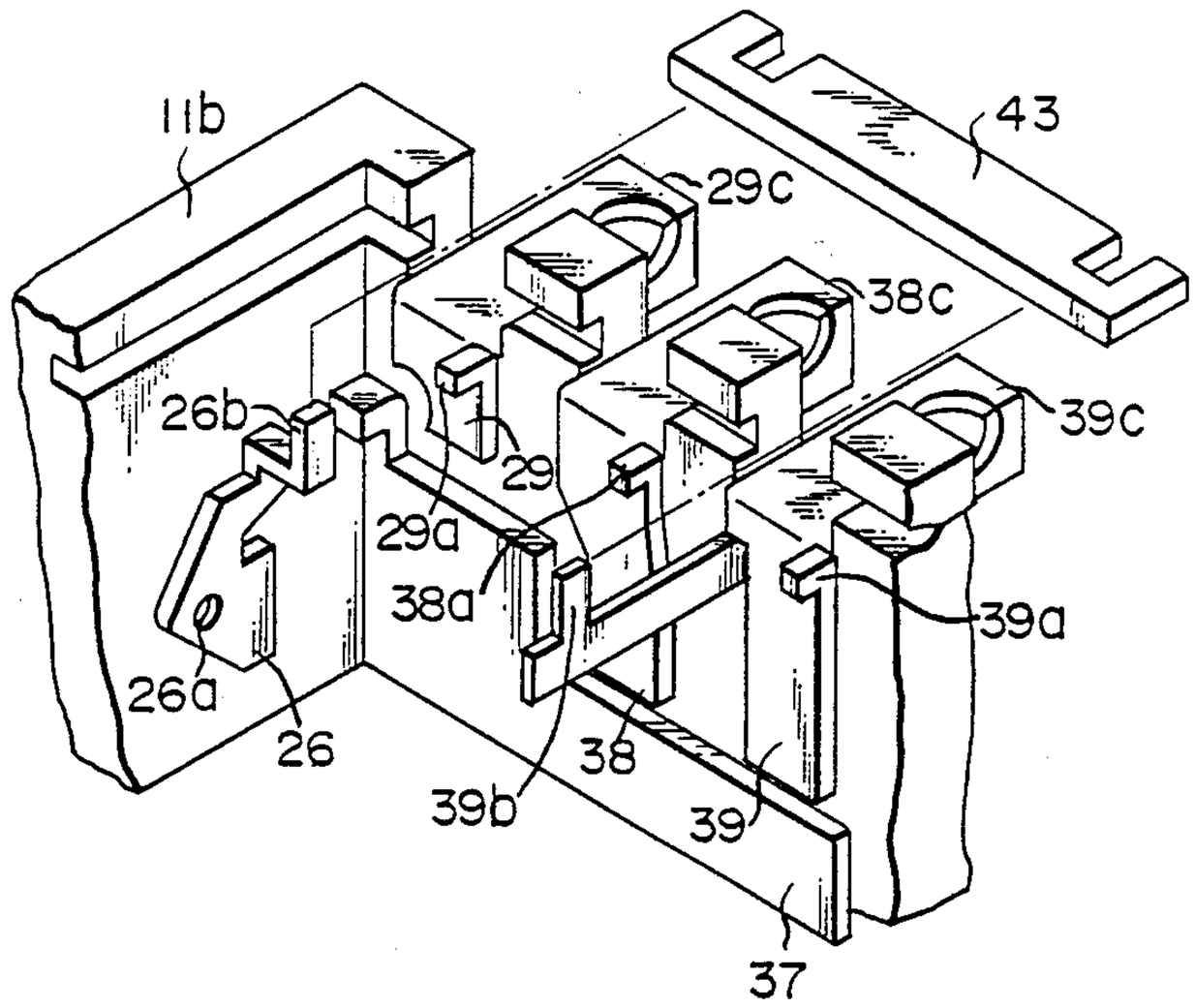

11b
43
29c
38c
26b
39c
29
29a
38a
39a
26a
26
38
39b
39
37

FIG. 10

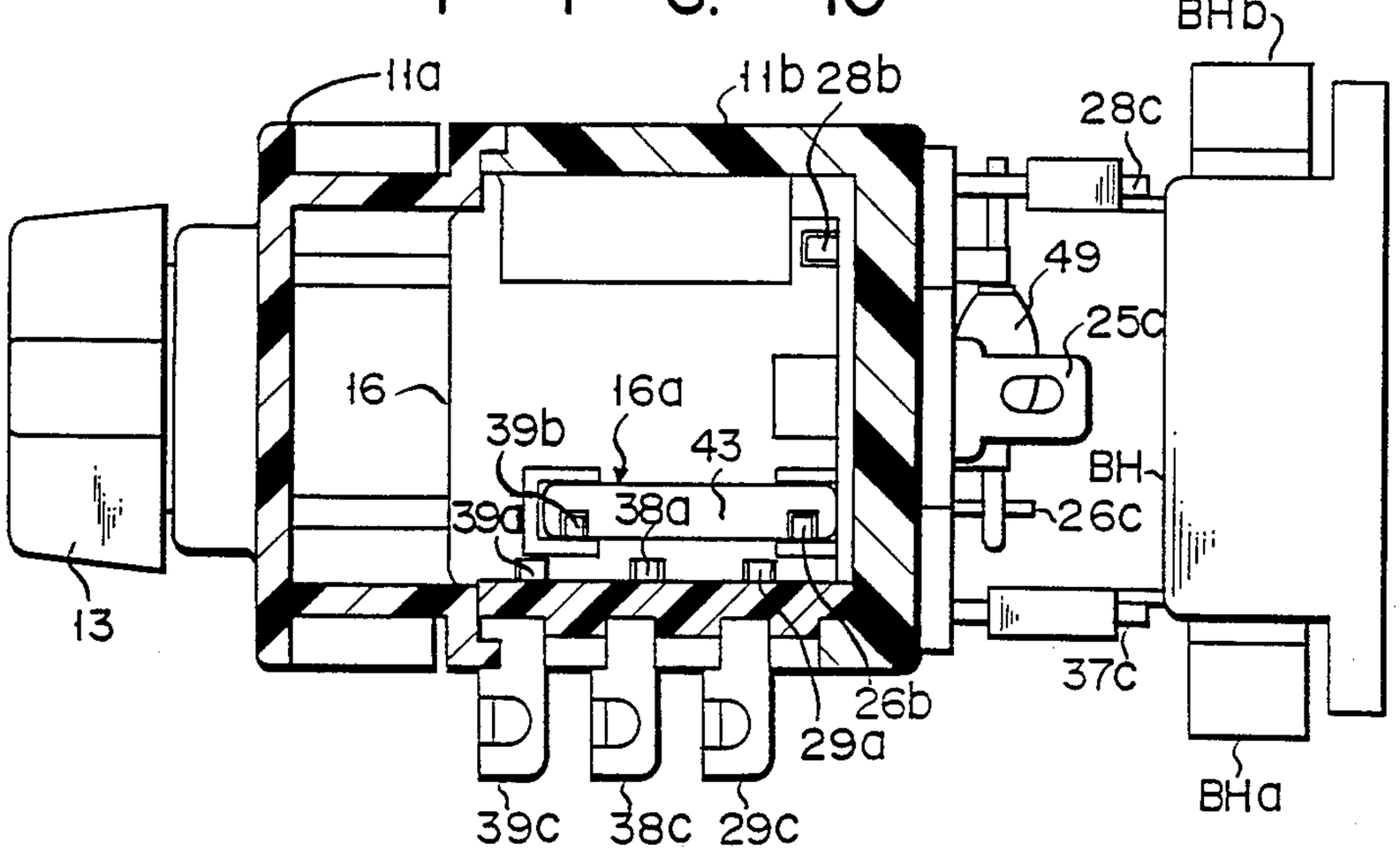

BHb
11a
11b
28b
28c
49
25c
16
16a
39b
43
BH
39a
38a
26c
13
37c
26b
29a
BHa
39c
38c
29c

FIG. 11

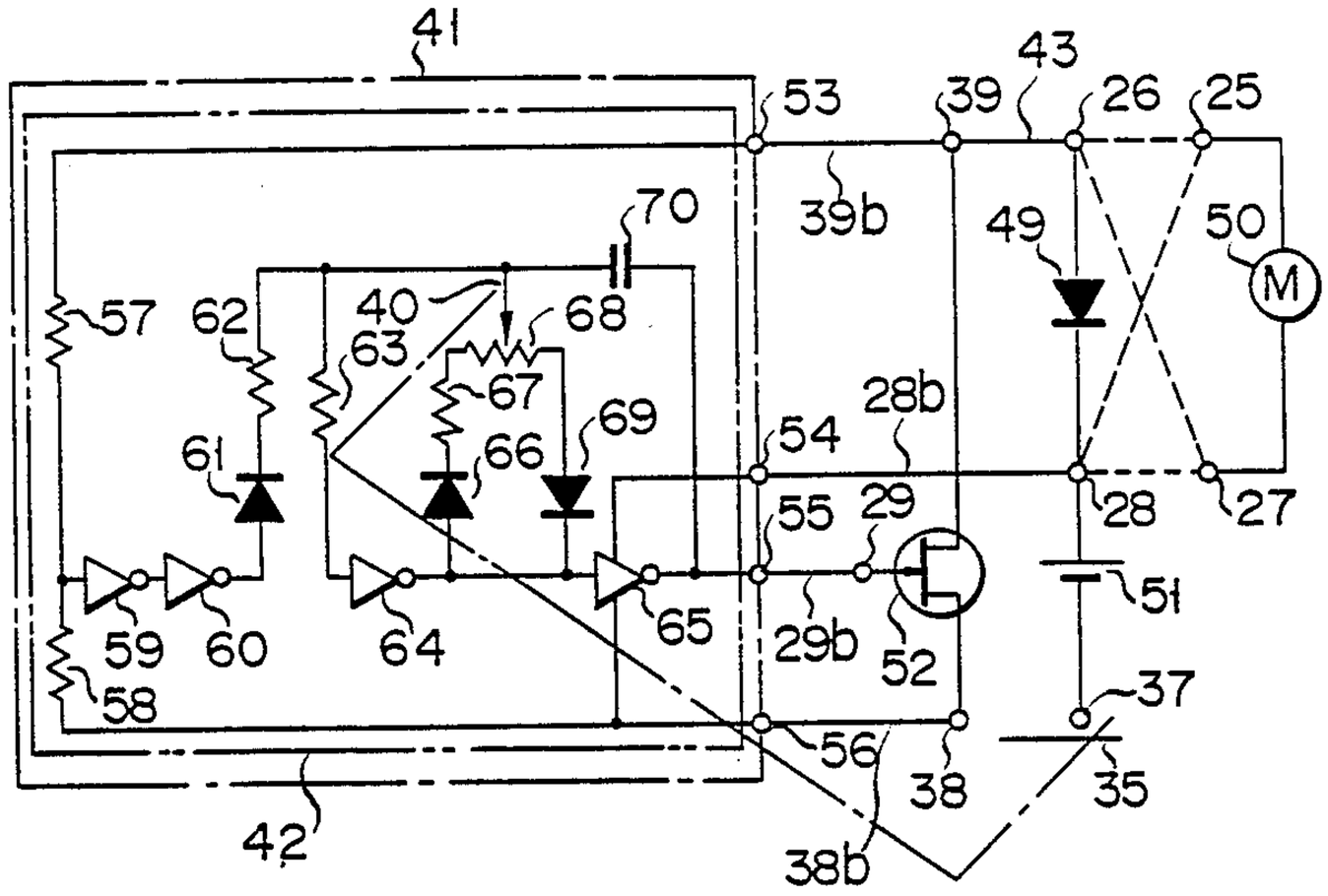

41
43
53
39
26
25
39b
70
49
50
M
57
62
40
68
63
67
28b
69
61
66
54
55
29
28
27
59
60
64
65
29b
52
51
58
37
56
38
35
42
38b

FIG. 12

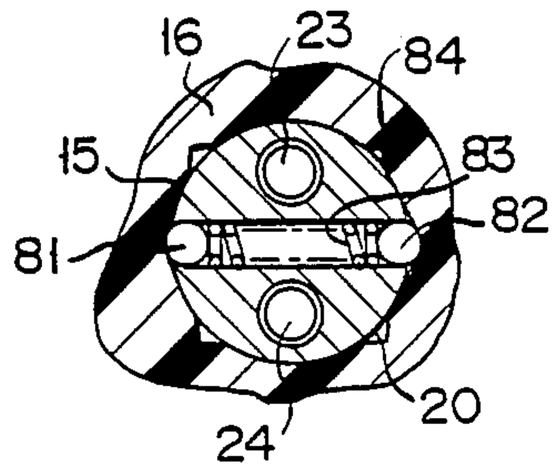

16
23
84
15
83
82
81
20
24

FIG. 13

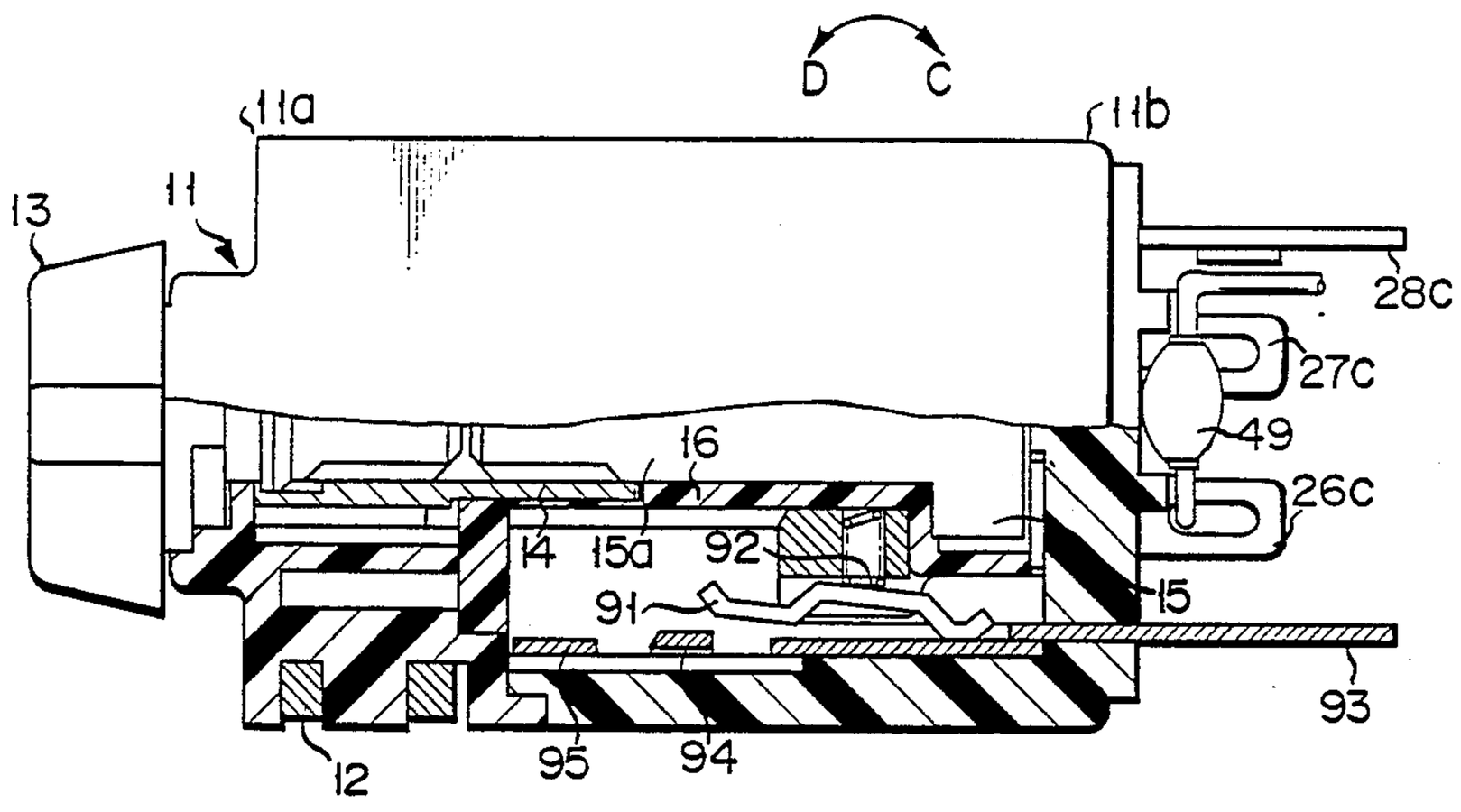
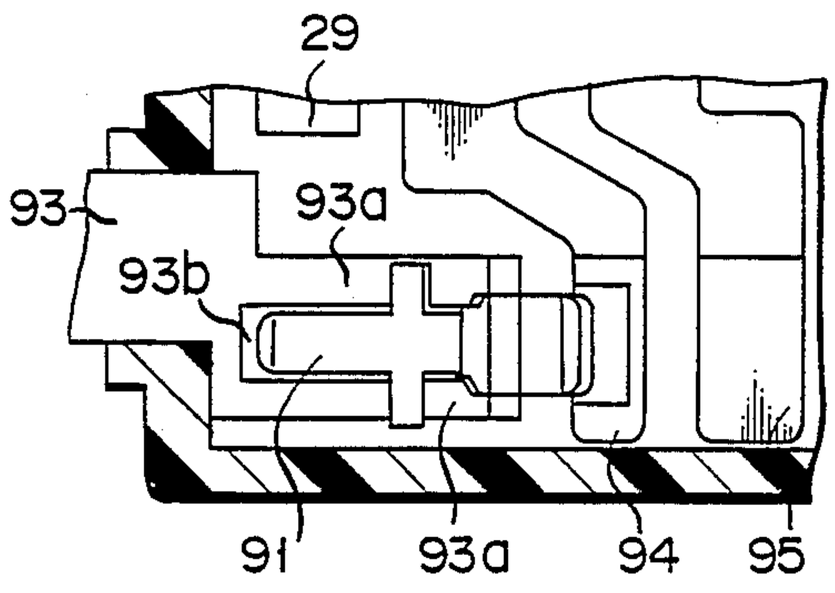

D
C
11a
11b
13
11
28c
27c
49
26c
16
14
15a
92
91
15
93
12
95
94

FIG. 14


29
93
93a
93b
91
93a
94
95

REVERSING SPEED CONTROL SWITCH

BACKGROUND OF THE INVENTION

The present invention relates to a reversing speed control switch which is applied to, for example, an electrical tool, and which can change the rotating direction and rotating speed of a motor.

Known switches capable of changing the rotating direction and rotating speed of a motor are described in U.S. Pat. Nos. 4,100,383, 4,097,704, and 3,755,640. However, in these switches, a reversing switch mechanism for reversing the rotating direction of the motor and a switch mechanism for turning on and off a power source, are arranged vertically. Thus, a space between the respective parts is widened, resulting in a large-sized switch. Since the reversing switch mechanism is separated from the power switch mechanism, it is difficult to achieve electrical connection therebetween.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a compact reversing speed control switch which can change the rotating direction and speed of a motor, and which can be easily assembled.

In order to realize the present invention, there is provided a reversing speed control switch comprising a casing; actuation means arranged on the casing; movable means which is arranged in the casing, and which is moved upon actuation of the actuation means; power switch means, arranged in the casing, for switching, on and off, a power source to be interlocked with the operation of the movable means; reversing switch means, connected to the power switch means, for switching the polarity of the power source supplied there from; reversing actuation means whose shaft portion, coupled to the reversing switch means, is arranged in the central portion of the casing, and whose actuation portion is arranged outside the casing; and speed control means, connected to the reversing switch means and power switch means, for performing speed control upon actuation of the actuation means, wherein the movable means, the power switch means, and speed control means are arranged around the shaft portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view showing a first embodiment of a reversing speed control switch;

FIG. **2** is a side view of the reversing speed control switch;

FIG. **3** is a rear view of the reversing speed control switch;

FIG. **4** is a sectional view taken along line IV—IV in FIG. **2**;

FIG. **5** is a sectional view taken along line V—V in FIG. **1**;

FIG. **6** is a sectional view taken along line VI—VI in FIG. **2**;

FIG. **7** is a sectional view taken along line VII—VII in FIG. **2**;

FIG. **8** is a partially cutaway sectional view showing a switch mechanism;

FIG. **9** is a perspective view showing a short-circuiting member;

FIG. **10** is a plan view of the short-circuiting member;

FIG. **11** is a circuit diagram showing a speed control circuit;

FIG. **12** is a sectional view showing the main part of a rotor according to a second embodiment of the present invention;

FIG. **13** is a partially cutaway plan view showing a reversing speed control switch mechanism according to a third embodiment of the present invention; and

FIG. **14** is a front view showing the main part of the power switch mechanism of FIG. **13**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will now be described, with reference to the accompanying drawings.

Referring to FIGS. **1** to **5**, a switch casing **11** is constituted by a first casing **11***a* and a second casing **11***b* (FIG. **4**). One end portion of a trigger **12** is pivotally supported on a side portion of the first casing **11***a*. Shaft **13***a* of a reversing actuator **13** for switching the rotating direction of a motor is pivotally supported on the front portion of first casing **11***a*. Connecting terminals **38***c* and **39***c* (FIGS. **1** and **2**) formed integrally with stationary contacts **38** and **39** (in FIG. **4**, to be described later) and connecting terminal **29***c* (FIGS. **1** to **3**) formed integrally with contact **29** (in FIG. **4**, to be described later) are arranged on the side portion of second casing **11***b*. Connecting terminals **25***c* (FIGS. **1** to **3**, and **5**), **26***c* (FIGS. **1** and **4**), **27***c* (FIGS. **2**, **4** and **5**), and **28***c* (FIGS. **1**, **4** and **5**) formed integrally with stationary contacts **25**, **26**, **27**, and **28** (in FIG. **6** to be described later) are arranged on the rear portion of casing **11**. Battery holder BH is provided with connecting terminals BHa and BHb (FIGS. **1** to **3**). Terminals BHa and BHb are connected to connecting terminals **28***c* and **37***c* (FIGS. **1** and **4**), and are connected to the positive and negative terminals of a battery (not shown). Connecting terminals **26***c* and **28***c* are connected across a diode **49** (FIGS. **1**, **4** and **5**).

As is shown in FIGS. **4** and **5**, shaft **13***a* of the reversing actuator **13** is coupled to shaft **15***a* of rotor **15**, via coupling member **14**. Rotor **15** pivotally extends through holding member **16** inside the second casing **11***b*, to be held in position thereby. As is shown in FIG. **4**, movable contacts **21** and **22** are movably buried in the end face of rotor **15**. Movable contacts **21** and **22** are biased, by coil springs **23** and **24** arranged therein, to project from rotor **15**. As can be seen in FIG. **6**, stationary contacts **25**, **26**, **27**, and **28** are arranged, at equal intervals along the inner surface portion of second casing **11***b*, facing movable contacts **21** and **22**. Movable contacts **21** and **22** can be selectively brought into contact with contacts **25** to **28** upon actuation of reversing actuator **13**, as is indicated by solid lines or dotted lines. Movable contacts **21** and **22** and stationary contacts **25** to **28** constitute a reversing switch mechanism.

As is shown in FIGS. **4** and **6**, recess portions **26***a* and **28***a* are formed in stationary contacts **26** and **28**. The distal end portions of movable contacts **21** and **22** are inserted in or removed from recess portions **26***a* and **28***a* upon actuation of reversing actuator **13**, generating a click sound when this occurs.

As can be seen in FIGS. **4** and **5**, movable element **30**, guided by casing **11***b* and holding member **16**, is arranged in second casing **11***b*, to be movable along the longitudinal direction of rotor **15**. Spring **31** is interposed between the end face of movable element **30** on the side of first casing **11***a* and the inner surface of first

casing **11***a*, such that movable element **30** is biased toward stationary contacts **25** to **28**. Engaging portion **32** is formed on the end portion of movable element **30** on the side of first casing **11***a*, and is engaged with one end portion of driving element **33**. The other end of driving element **33** is pivotally held by trigger **12**, and its intermediate portion abuts against supporting portion **34** formed on the lower portion of first casing **11***a*. Therefore, when trigger **12** is operated in the direction indicated by arrow A as shown in FIG. **5**, driving element **33** is pivoted about supporting portion **34**, in the direction indicated by arrow B, and movable element **30** is moved toward first casing **11***a*, accordingly.

As is shown in FIGS. **4** and **7**, movable contact **35** is movably held on one side portion of movable element **30**. Movable contact **35** is biased toward the inner surface of second casing **11***b* by spring **36** buried in movable element **30**. As can be seen in FIG. **8**, common contact **37**, stationary contacts **38** and **39**, and contact **29** are disposed on the inner surface of second casing **11***b*, and common contact **37** and stationary contacts **38** and **39** are selectively connected to movable contact **35**, upon operation of movable element **30**.

As is shown in FIGS. **4** and **7**, contact element **40** is arranged on the other side portion of movable element **30**. Contact element **40** is in movable contact with resistor **68** (to be described later) of circuit board **41** arranged on the upper surface portion of holding member **16**.

As is shown in FIGS. **8**, **9**, and **10**, projections **38***a*, **39***a*, and **29***a* are arranged on stationary contacts **38** and **39** and on the side surface portion of contact **29** inside second casing **11***b*. Projections **38***a*, **39***a*, and **29***a* project from the upper surface portion of holding member while member **16** is stored in casing **11***b*, so as to be connected to a predetermined circuit pattern of circuit board **41**.

Stationary contact **39** constituting a switch mechanism and stationary contact **26** constituting the reversing switch mechanism respectively have projections **39***b* and **26***b*. Projections **39***b* and **26***b* are arranged in recess portion **16***a* formed in holding member **16**, while holding member **16** is situated in second casing **11***b*. In this state, projections **39***b* and **26***b* are connected to short-circuiting member **43**, as is shown in FIG. **11**.

The assembly of this trigger switch will now be described.

(1) Reversing actuator **13** is assembled in first casing **11***a*.

(2) Movable element **30** with movable contact **35** is stored in second casing **11***b* in which stationary contacts **25** to **28** constituting a reversing switch mechanism, and common contact **37**, stationary contacts **38** and **39**, and contact **29** constituting a switching mechanism are arranged.

(3) Rotor **15** assembled with movable contacts **21** and **22** is assembled in holding member **16**, and this assembly is assembled in second casing **11***b*.

(4) Projections **26***b* and **39***b* of stationary contacts **26** and **39** are connected by short-circuiting member **43**, both projections being soldered thereto.

(5) Circuit board **41** assembled with contact element **40** is located on holding member **16**, and the patterns of circuit board **41** are connected, by means of soldering, to projections **28***b*, **38***b*, **39***b*, and **29***b* of stationary contacts **28**, **38**, and **39**, and contact **29**.

(6) Spring **31** and coupling member **14** are assembled in movable element **30** and holding member **16**.

(7) First casing **11***a* is bonded to second casing **11***b*, after assembly steps (2) to (6).

(8) Driving element **33** and trigger **12** are assembled in first casing **11***a*, thereby completing the assembly.

Control circuit **42** provided on circuit board **41**, and a connecting state between control circuit **42** and the stationary contacts will now be described, with reference to FIG. **11**. The same reference numerals in FIG. **11** denote the same parts as in FIGS. **1** to **10**.

Referring to FIG. **11**, motor **50** is connected between stationary contacts **25** and **27** (connecting terminals **25***c* and **27***c*), and diode **49** is connected between stationary contacts **26** and **28** (connecting terminals **26***c* and **28***c*). Battery **51** is connected between stationary contact **28** and common contact **37**, in the direction shown in FIG. **11**, and stationary contacts **26** and **39** (projections **26***b* and **39***b*) are connected by short-circuiting member **43**. The drain and source electrodes of FET (Field-Effect Transistor) **52** are respectively connected between stationary contacts **39** and **38** (connecting terminals **39***c* and **38***c*). The gate electrode of FET **52** is connected to stationary contact **29** (connecting terminal **29***c*). Stationary contacts **39**, **28**, **29**, and **38** are connected to circuit patterns **53**, **54**, **55**, and **56** of control circuit **42** constituting an oscillator, through projections **39***b*, **28***b*, **29***b*, and **38***b*, respectively. Resistors **57** and **58** are series-connected between patterns **53** and **56**. Inverter circuits **59** and **60**, diode **61**, resistors **62** and **63**, and inverter circuits **64** and **65** are series-connected between the node between resistors **57** and **58** and pattern **55**, in the order mentioned. A series circuit consisting of diode **66**, resistors **67** and **68**, and diode **69** is parallel-connected between inverter circuits **64** and **65**. Capacitor **70** and contact element **40**, which is in contact with resistor **68**, and which constitutes a variable resistor, are connected between the node between resistors **62** and **63**, and pattern **55**.

In the above arrangement, when reversing actuator **13** is actuated to connect stationary contacts **25**, **26**, **27**, and **28**, as indicated by the solid line in FIG. **6**, motor **50** is rotated in the forward direction. When reversing actuator **13** is operated to connect stationary contacts **25**, **28**, **26**, and **27**, as indicated by the dotted line in FIG. **6**, motor **50** is rotated in the reverse direction.

In the state where reversing actuator **13** is appropriately operated, when trigger **12** is operated, common contact **37** and stationary contact **38** are connected to each other by movable contact **35**, upon movement of movable element **30**. Then, control circuit **42** is powered to perform oscillation. A pulse signal output from control circuit **42** is supplied to the gate of FET **52**, to allow the switching operation thereof. In this state, when trigger **12** is withdrawn further, contact element **40** slides along resistor **68**, while common contact **37** and stationary contact **38** are connected to each other by movable contact **35**. Thus, the duty ratio of the pulse signal output from control circuit **42** is gradually increased, and power supplied to FET **52** increases. Therefore, the rotating speed of motor **50** increases accordingly. When trigger **12** is withdrawn to its limit, common contact **37** and stationary contact **39** are connected by movable contact **35**, and maximum power is fed to motor **50**, thus rotating motor **50** at maximum speed.

When the actuation force of trigger **12** is weakened from this state, movable element **30** and trigger **12** are returned by the biasing force of spring **31**. Upon this movement, movable contact **35** and contact element **40**

are operated in the reverse direction, as is described above, and the rotating speed of motor **50** is decreased. When trigger **12** is returned to the position shown in FIG. **1** or **5**, motor **50** is stopped.

With the above embodiment, the following effects can be obtained:

The switch mechanism for turning the power source on and off, the reversing switch mechanism for switching the polarity of the output voltage, and the speed control circuit are arranged around holding member **16** inside the switch casing. Therefore, since the power switch mechanism, the reversing switch mechanism, and the speed control circuit have good space efficiency, the switch casing can be rendered compact.

The reversing switch mechanism and the power switch mechanism are arranged on adjacent inner surfaces of switch casing **11**, and the speed control circuit is arranged on the surface perpendicular thereto. Therefore, the speed control circuit, the reversing switch mechanism, and the power switch mechanism can be arranged adjacent to each other, resulting in ease of electrical connection therebetween.

Furthermore, in stationary contacts **26** and **39**, their projections **26***b* and **39***b* are connected by short-circuiting member **43**. Therefore, assembly this reversing speed control switch is quite easy.

Connections between stationary contacts **39**, **28**, **29**, and **38** and circuit patterns **53**, **54**, **55**, and **56** of circuit board **41** are performed through projections **39***b*, **28***b*, **29***b*, and **38***b*, respectively, resulting in easy assembly thereof.

Another embodiment of the present invention will now be described. The same reference numerals in this embodiment denote the same parts as in FIGS. **1** to **10**.

FIG. **12** shows a modification of rotor **15**. Steel balls **81** and **82** are buried in the end portion of rotor **15**, and are biased toward the inner surface portion of holding member **16**, by means of spring **83** arranged therebetween. A plurality of cams **84** are formed on the inner surface portion of holding member **16**, as is shown in FIG. **12**. Steel balls **81** and **82** are urged against cams **84**. Therefore, when reversing actuator **13** is pivoted, rotor **15** is driven upon operation of steel balls **81** and **82** and cams **84**.

FIGS. **13** and **14** show a modification of the switch mechanism of the present invention. Movable contact **91** is arranged on movable element **30**. Movable contact **91** is biased toward the inner surface of second casing **11***b* by means of spring **92** buried in movable element **30**. Common contact **93** and stationary contacts **94** and **95** are disposed on the inner surface of second casing **11***b*. Stepped portion **93***a* along which one end portion of movable contact **91** slides and recess portion **93***b* which can store the other end portion of movable contact **91** are arranged on common contact **93**. When movable element **30** is located at a position shown in FIG. **4** or **5**, one end portion of movable contact **91** is located on stepped portion **93***a*, and the other end portion thereof is located in recess portion **93***b*. Therefore, movable contact **91** is pivoted in the direction indicated by arrow C, and one end portion of movable contact **93** is separated from stationary contact **94**. When movable element **30** is moved toward first casing **11***a* upon operation of trigger **12**, one end portion of movable contact **91** is separated from stepped portion **93***a*, and movable contact **91** is pivoted in the direction indicated by arrow D. For this reason, one end portion of movable contact **91** is sequentially brought into contact with stationary contacts **94** and **95** while the other end portion thereof is in contact with common contact **93**.

When the operating force of trigger **12** is released, an operation the reverse of the above description is performed.

The present invention is not limited to the above embodiments, and various other changes and modifications may be made within the spirit and scope of the invention.

What is claimed is:

1. A reversing speed control switch comprising:

a casing;

a holding member within the casing;

movable element means within the casing for movement linearly along the holding member;

trigger actuation means outside the casing for so moving the movable element means;

power switch means having a plurality of first stationary contacts on an inner, side surface of the casing and a first movable contact on the movable element means selectively movable into contact with one of the first stationary contacts upon the movement of the movable element means for switching a power source connected to the first stationary contacts on and off in response the movement of the movable element means;

reversing actuating means having a shaft rotatably extending through the holding member and an actuator outside the casing to rotate the shaft;

reversing switch means having at least one second movable contact on an inner end face of the shaft and a plurality of second stationary contacts opposing the end face of the shaft on an inner, end surface of the casing adjacent to the inner, side surface of the casing with the plurality of first stationary contacts, the second stationary contacts being connected to the first stationary contacts for reversing the polarity of power switched on by the power switch means; and

speed control means operative between the movable element means and the holding member and connected to the first and second stationary contacts for controlling the power reversibly switched on thereby in accordance with the movement of the movable element means, whereby to provide speed control.

2. The reversing speed control switch according to claim **1**, wherein the speed control means comprises a speed control circuit including a variable resistor and a slider movable relative thereto by the movable element means.

3. The reversing speed control switch according to claim **1**, wherein the first and second stationary contacts include a projection extending into the holding member and connected to a short-circuiting member.

4. The reversing speed control switch according to claim **1**, wherein the second movable contact is movable into and out of recesses respectively in the second stationary contacts.

5. The reversing speed control switch according to claim **1**, wherein the shaft has a storage hole and the reversing actuating means further comprises steel balls, a spring for urging the steel balls in a direction away from the storage hole and cam means on an inner surface of the holding member for engaging one of the steel balls with the storage hole.

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